

Disk-planet interactions

F. Masset

Disk Frame



A few orbits

Planet Frame

Type I migration
(corotating frame)



F. Masset 2002

100+ orbits, small planet

Planet Frame

Gap opening



F. Masset 2002

100 orbits, large planet

Density Wave, Lindblad Resonance

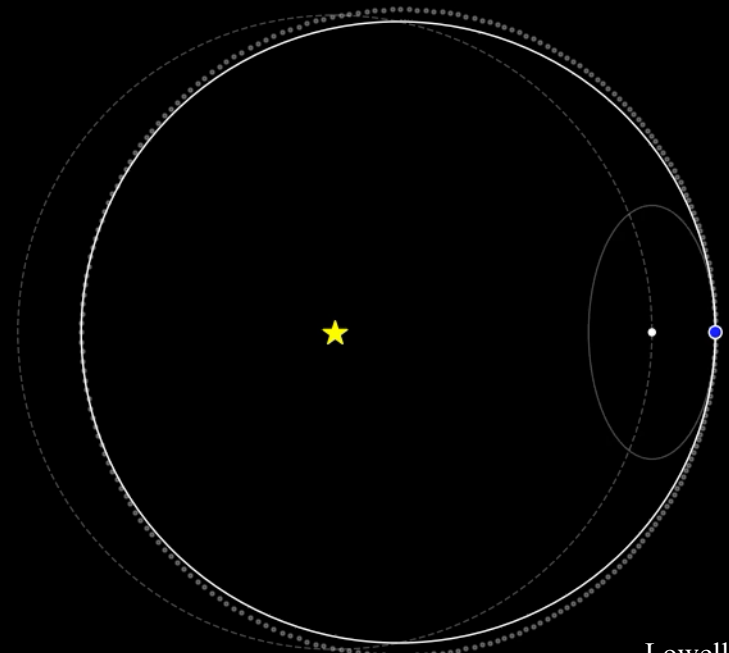
Epicyclic Motion Around a Guiding Center

Circular orbit

Eccentric orbit

- Guiding center
- Epicyclic motion

Resonance



Lowell Peltier

For Keplerian disks
epicyclic frequency = Keplerian frequency

$$\kappa = \Omega_K$$

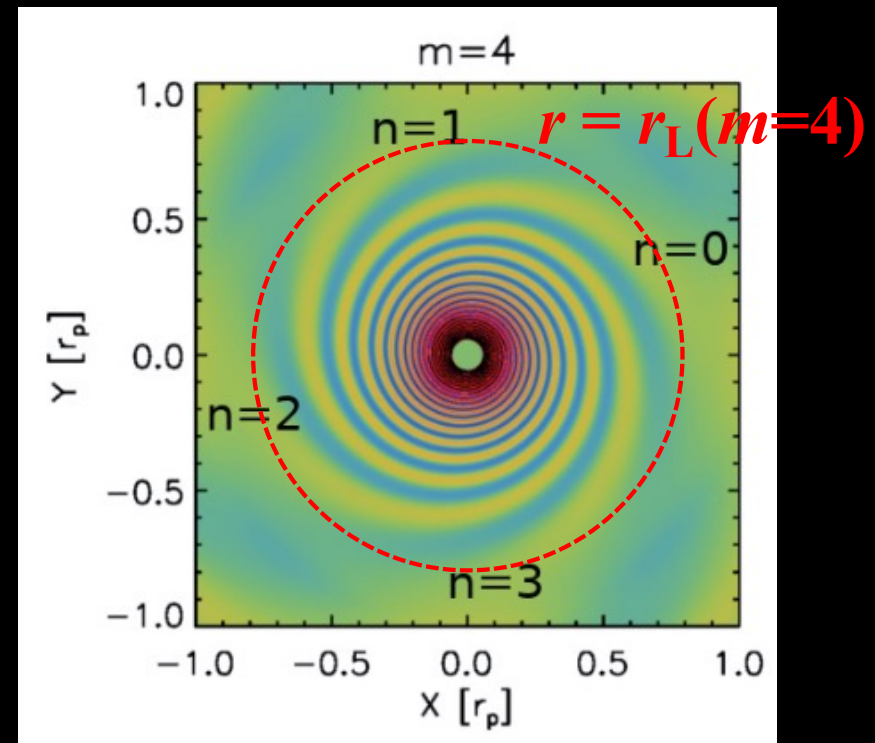
Density Waves are Launched at Lindblad Resonance Locations

Planet potential at $r = 1$

Waves launched at $m = 4$ inner Lindblad Resonance

What happens to the waves after launch?

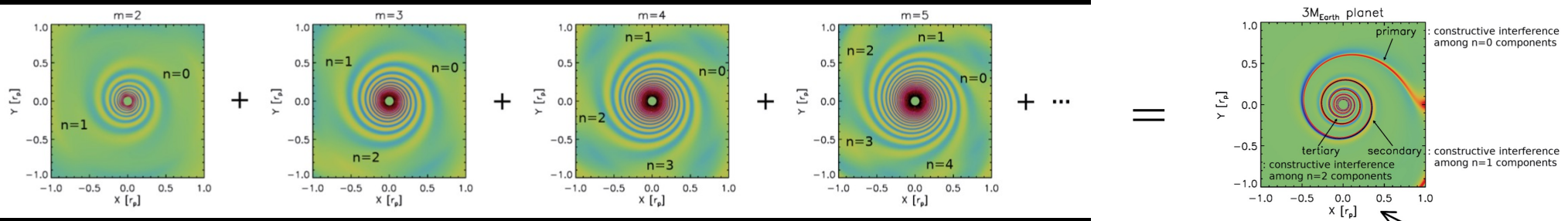
- Radial direction: Propagate at sound speed
- Azimuthal direction: Carried away by the background Keplerian shear



Bae & Zhu 2018

Density Waves are Launched at Lindblad Resonance Locations

Constructive interference of all the m -th waves launched at Lindblad resonances \rightarrow Spiral density wave



Bae & Zhu 2018